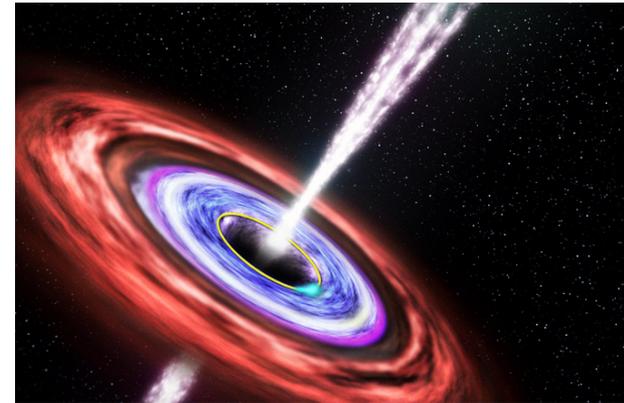
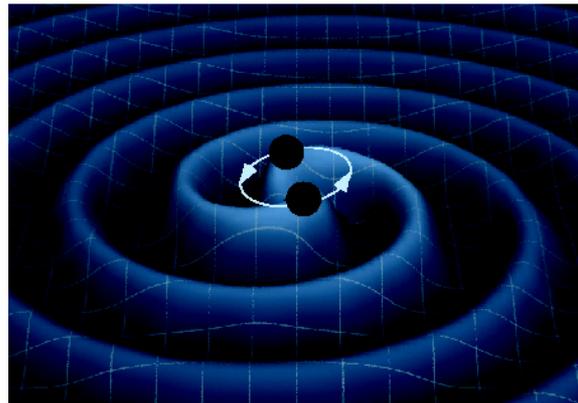
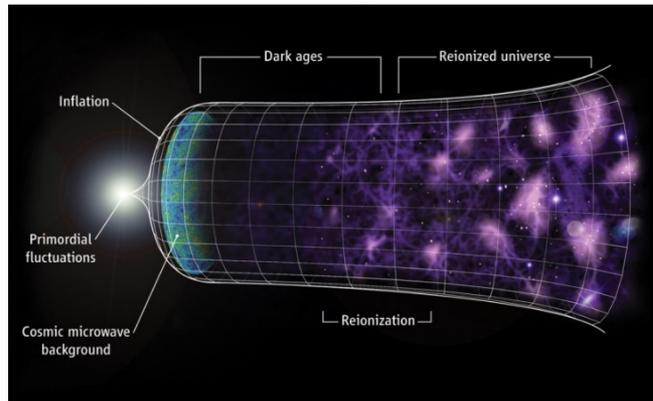
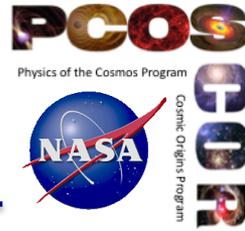


Physics of the Cosmos Program Analysis Group Report

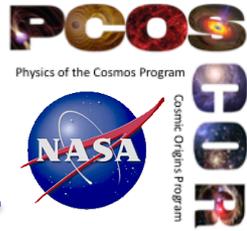


Graça Rocha

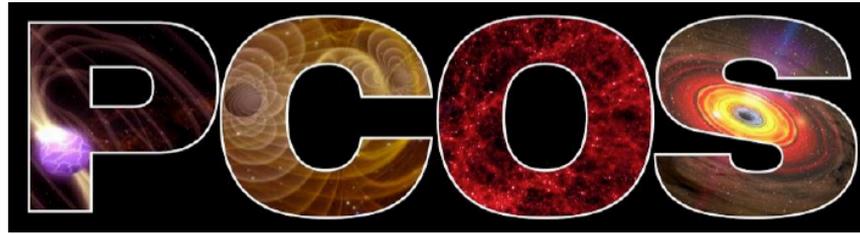
Jet Propulsion Laboratory/Caltech
Chair, Physics of the Cosmos Program Analysis Group, PhysPAG
graca.m.rocha@jpl.nasa.gov; graca@caltech.edu

Virtual APS April Meeting, 18 April 2020

Outline



- **Introduction to PCOS and PhysPAG (reminder)**
- **SIG Highlights, Activities and Goals**
- **MultiMessenger Astrophysics SAG – see talk by John Conklin in this session**



Physics of the Cosmos Program Office Purpose:

to explore some of the most fundamental questions regarding the physical forces and laws of the universe:

- the validity of Einstein's General Theory of Relativity and the nature of spacetime;
- the behavior of matter and energy in extreme environments;
- the cosmological parameters governing inflation and the evolution of the universe; and
- the nature of dark matter and dark energy.

Physics of the Cosmos spans the fields of high-energy astrophysics, cosmology, and fundamental physics, with a wide range of science goals. These include the following:

- General Relativity and the Nature of Spacetime
- Massive Black Holes and the Evolution of Galaxies
- Matter and Energy in the Most Extreme Environments
- Dark Energy
- Big Bang and the Evolution of the Universe

More resources: <https://pcos.gsfc.nasa.gov>



Activities supporting PCOS goals and priorities:

- Managed by the PCOS/COR Program Office at NASA's Goddard Space Flight Center and reported to NASA Headquarters.
- Include:
 - **Mission studies** and pre-project mission oversight, insight, and support
 - **Strategic technology (SAT)** maturation oversight, insight, and support
 - **Community engagement**, including via the Physics of the Cosmos Program Analysis Group (PhysPAG)
 - Maintaining **science cognizance** to enable more successful NASA strategic planning

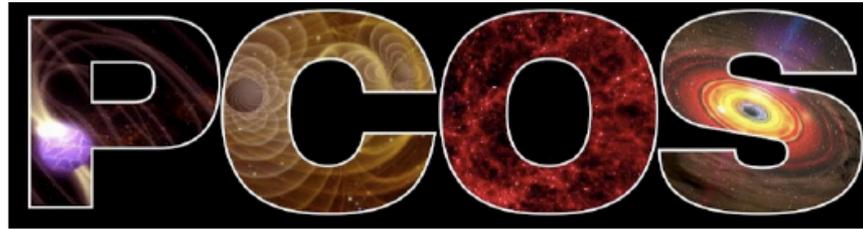
The PCOS Program Office hosts

- Athena Study Office
- LISA Study Office

and oversees

- science and
- technology activities

for NASA's contribution to these ESA-led and other strategic missions.

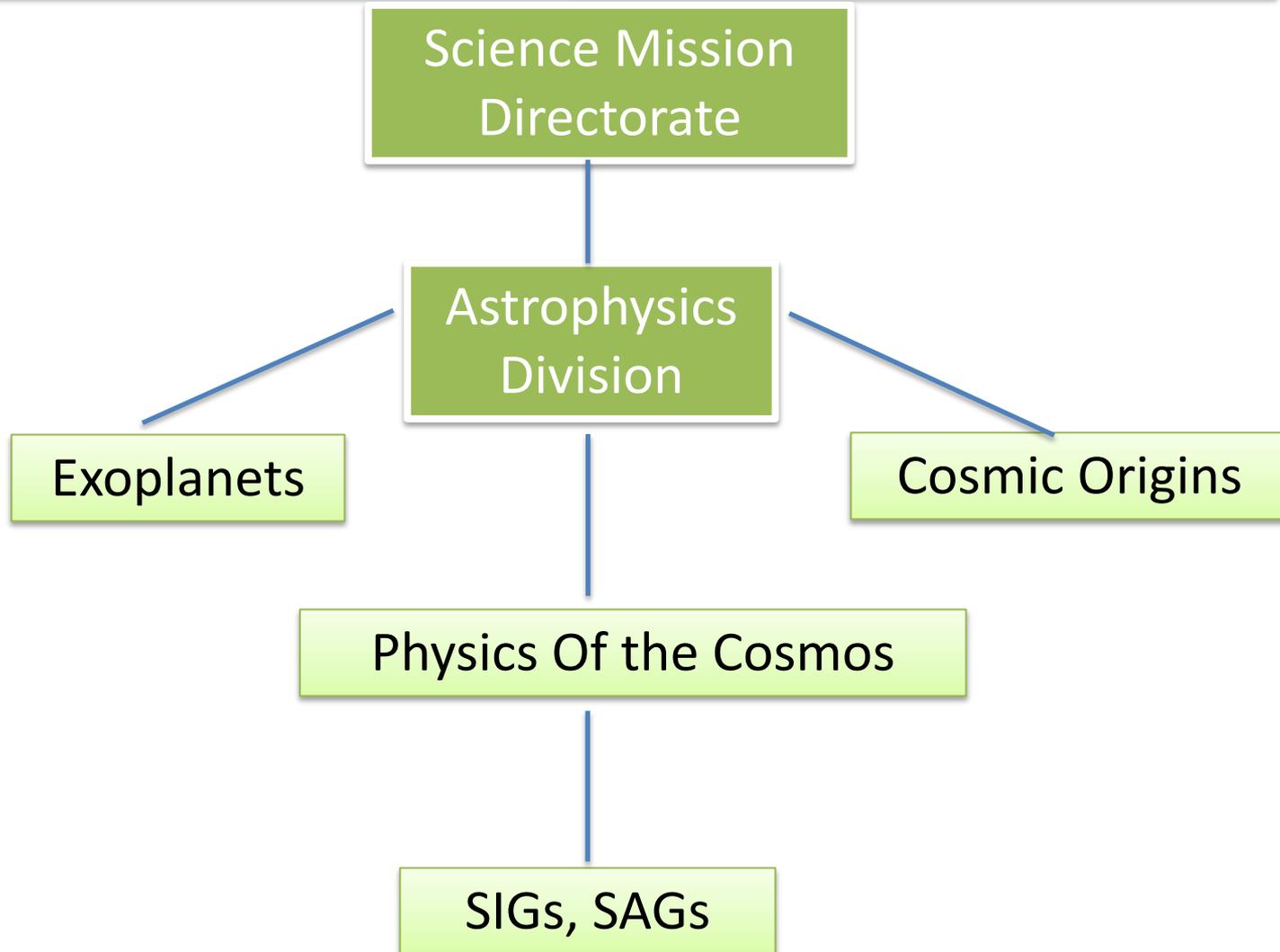
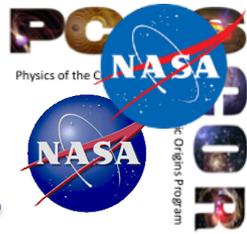


PCOS Chief Scientist enables ground-breaking science from space by working at the interfaces between missions and studies, technology, the community, and NASA HQ.

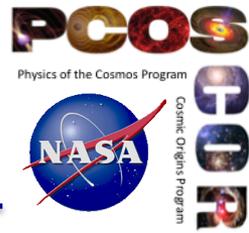
Current PCOS Science Goals and Priorities:

- Ensure a more successful **Decadal survey** by supporting community preparations and HQ activities, spanning the range of inputs: from science to missions, technology, and state of the profession, which all impact our ability to do ground-breaking science
- Ensure more **successful missions** by
 - supporting on-going mission studies and pre-projects, eg LISA, Lynx, Athena;
 - through technology efforts, eg SAT;
 - by coordinating with current missions; and
 - by preparing for studies for mission recommended by the Astro2020 Decadal
- **Engage the community** to support a successful APD portfolio.

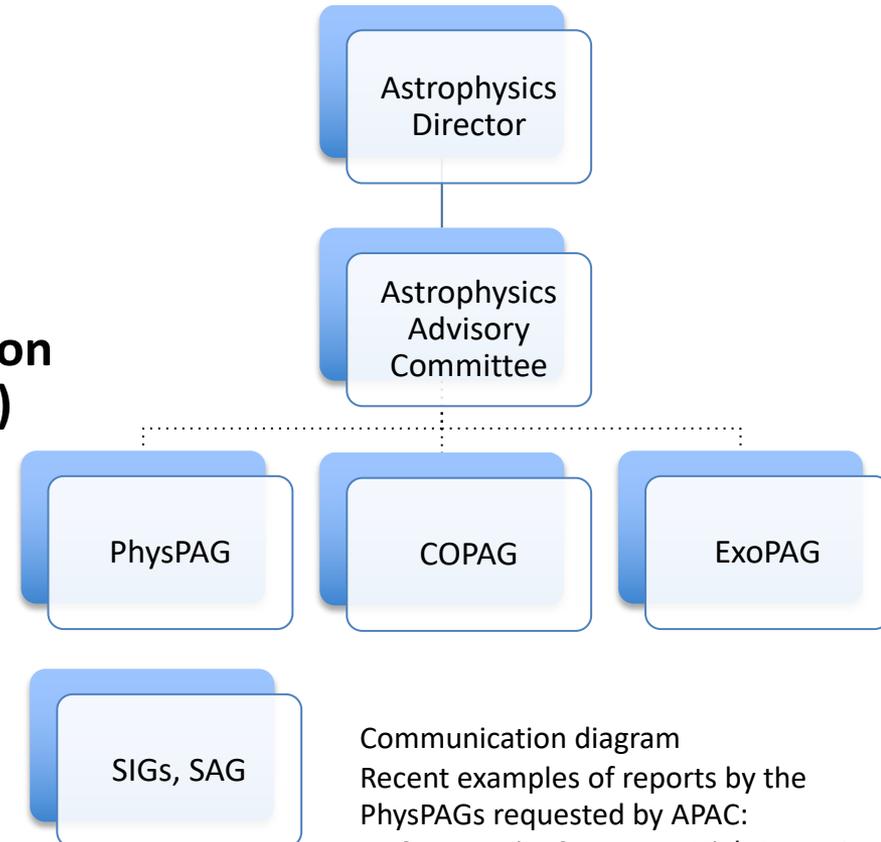
Communication network



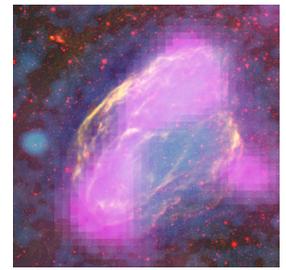
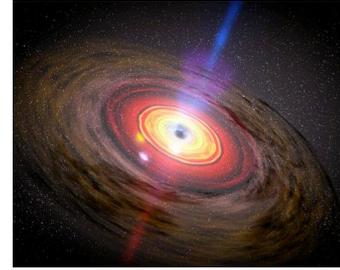
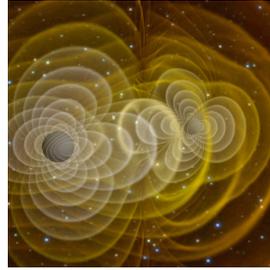
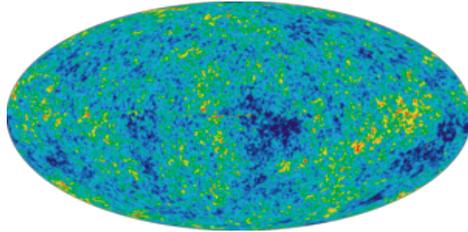
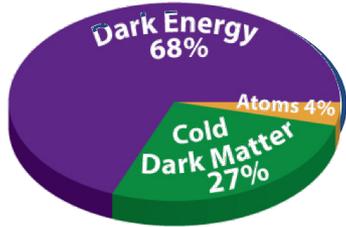
Communicating with NASA Astrophysics via the Program Analysis Groups (PAGs)



- The Physics of the Cosmos Program Analysis Group (**PhysPAG**) coordinates input and analysis from the scientific community in support of the PCOS program objectives.
- Study Analysis Groups (**SAGs**) **conduct specific analyses. PCOS just closed a SAG on Multi Messenger Astrophysics (MMASAG)**
- Science Interest Groups (SIGs) are longer-standing discipline fora.
 - IP SIG
 - GW SIG
 - XR SIG
 - GR SIG
 - CR SIG
 - CoS SIG

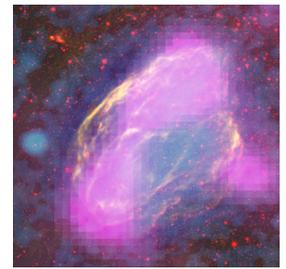
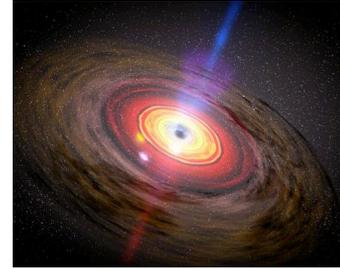
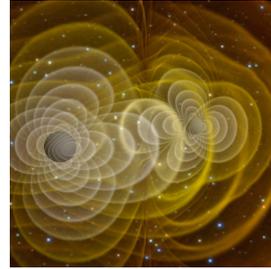
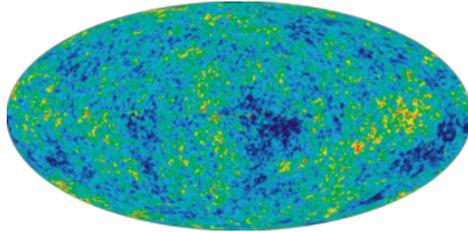
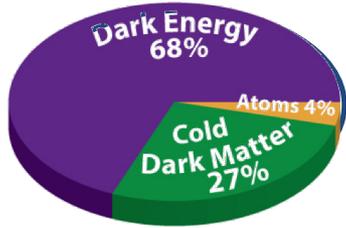
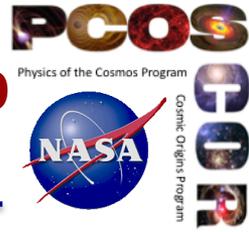


Physics of the Cosmos Science Objectives



- Increase our knowledge of dark energy
- Precisely measure cosmological parameters governing evolution of the universe and test inflation hypothesis of Big Bang
- Test validity of Einstein's General Theory of Relativity and investigate nature of spacetime
- Understand formation and growth of massive black holes and their role in evolution of galaxies
- Explore behavior of matter and energy in its most extreme environments

Physics of the Cosmos Program Analysis Group



□ Six Science Interest Groups (SIGs)

- Cosmic Ray (CR SIG)
- Cosmic Structure (CoS SIG)
- Gamma-ray (GR SIG)
- Gravitational Wave (GW SIG)
- Inflation Probe (IP SIG)
- X-ray (XR SIG)

Want go get involved?

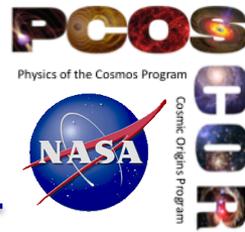
Go to:

<https://pcos.gsfc.nasa.gov/phypag/sigs-sags.php>

and subscribe to the relevant SIG emailing list

Annual call again this fall!

PhysPAG EC Membership

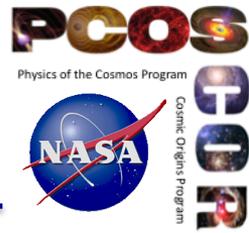


Name	Affiliation	Area of Expertise	Term Ends
John Conklin (Chair Emeritus)	Univ. of Florida	GW SIG	Dec 2020
Graça Rocha (Chair)	JPL/Caltech	IP SIG/CoS SIG	Dec 2020
Sylvain Guiriec	George Washington Univ.	GR SIG	Dec 2020
Kevin Huffenberger	Florida State Univ.	CoS SIG/IP SIG	Dec 2020
James Rhoads	GSFC	CoS SIG	Dec 2020
Abigail Viereggs	Univ. of Chicago	IP SIG / CR SIG	Dec 2020
Nicolas Yunes	Montana State Univ.	GW SIG	Dec 2020
Ryan Hickox (Vice Chair)	Dartmouth College	XR SIG	Dec 2021
Marcos Santander	Univ. of Alabama	CR SIG	Dec 2021
Jillian Bellovary	Queensborough Comm Coll.	GW SIG / XR SIG	Dec 2022
Sean McWilliams	WVU	GW SIG	Dec 2022
Bindu Rani	SURA, GSFC	GR SIG	Dec 2022
Grant Tremblay	SAO	XR SIG	Dec 2022

*New Roles

*New members as of January 2020

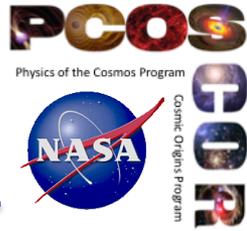
the Cosmic Ray Science Interest Group highlights and updates



□ CR SIG

- Hosted a mini-symposium at 2019 April APS meeting in Denver on direct and indirect cosmic-ray measurements and ultra-high-energy neutrinos
- ~**16 Science White Papers** submitted to Astro2020 on cosmic rays, either addressing questions of origin, composition, spectrum, or their multi-messenger connections
- SIG chairs encouraged the community to contact them with questions and suggestions on activities or topics they would like to see the group address

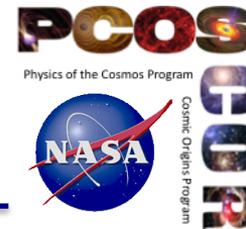
the Gamma-ray Science Interest Group highlights and updates



□ GR SIG

- Coordinated sessions at AAS in Seattle, HEAD meeting in Monterey, and 2020 AAS in Honolulu
- Produced webpage to coordinate relevant Science White Papers for Astro2020. Held workshops and telecons to organize community in writing of white papers.
 - **74 Science White Papers** mentioned gamma-rays in the title or abstract.
- Contributed a paragraph to the May 2019 HEAD newsletter on the status of Gamma-ray missions (Transient Astrophysics Observatory (ISS-TAO), Compton Spectrometer and Imager (COSI-X), Glowbug, BurstCube)

the Gamma-ray Science Interest Group highlights and updates



Gamma-Ray SIG Session

Wednesday, 8 January 2020
1:15 P.M.–2:45 P.M., Room: : 303A

GRSIG session at AAS meeting

Agenda

Welcome

1:15–1:25 P.M. **Fermi Result Highlights**

1:25–1:35 P.M. **COSI Result Highlights**

1:35–1:45 P.M. **Status of Glowbug**

1:45–1:55 P.M. **AMEGO**

1:55–2:05 P.M. **GRAMS**

2:05–2:15 P.M. **ETCC/SMILE**

2:15–2:25 P.M. **MoonBEAM**

2:25–2:35 P.M. **TAP**

2:35–2:45 P.M. **Gamow**

Open Discussion if time permits

Sylvain Guiriec

Liz Hays

Carolyn Kierans

Eric Grove

Julie McEnery

Tsuguo Aramaki

Toru Tanimori

Michelle Hui

Judy Racusin

Nick White

WebEx

Gamma-Ray SIG Session

Wednesday, 8 January 2020

1:00 P.M. | Hawaii Time (Honolulu, GMT-10:00) | 2 hrs

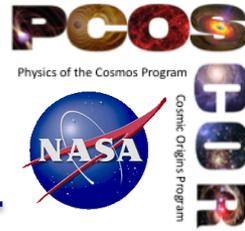
Meeting number (access code): 905 835 799

Meeting password: Aas2020!

When it's time, [join the meeting](#).



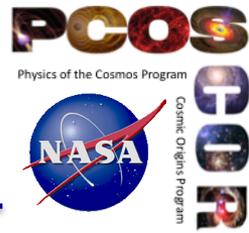
the Gravitational Wave Science Interest Group highlights and updates



□ GW SIG

- Helped organize the community regarding **3 APC white papers for Astro2020:**
 - LISA mission APC, building the WG field, GW Astronomy Beyond LISA
- Helped organize the community regarding **4 Voyage2050 white papers**
 - Improved sensitivity in LISA band, Low frequencies, Mid-band frequencies,
Improved sky localization
- Continued interactions with the LISA Consortium regarding development of LISA

the Gravitational Wave Science Interest Group highlights and updates

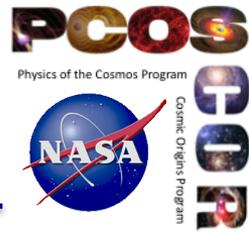


□ GW SIG

- Organized session at January 2020 AAS, Honolulu
 - GWSIG Overview
 - LISA mission update
 - Intro talks by new SIG Co-chairs,
 - Jillian Bellovary, Sean McWilliams
 - NASA LISA Study Team update
- Organized session at April APS 2020, Washington, DC
 - GWSIG and PCOS overview
 - LISA mission update
 - NANOGrav update
- Discussing ways to incorporate more activities outside of LISA
 - LIGO/Virgo and associated EM follow-ups
 - Pulsar timing arrays
 - Future space GW missions beyond LISA



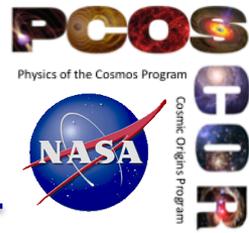
the Inflation Probe Science Interest Group highlights and updates



□ IP SIG

- Main activity of community was production of ~ **20 Science whitepapers** and **8 APC whitepapers** for Astro2020 decadal.
- **APC whitepapers:**
 - 3 related explicitly to space-based projects: **PICO**, **LiteBIRD**, and description of a program for **CMB spectral distortions**
 - Others related to technological development or ground-based projects (Ground-based efforts highly complementary to space based efforts)
 - 1 paper, “The need of better tools to design future CMB experiments”, has a sub-section dedicated to space vs ground complementarity
- For information on the SWP please take a look at the IP SIG webpage

the Inflation Probe Science Interest Group highlights and updates



□ IP SIG

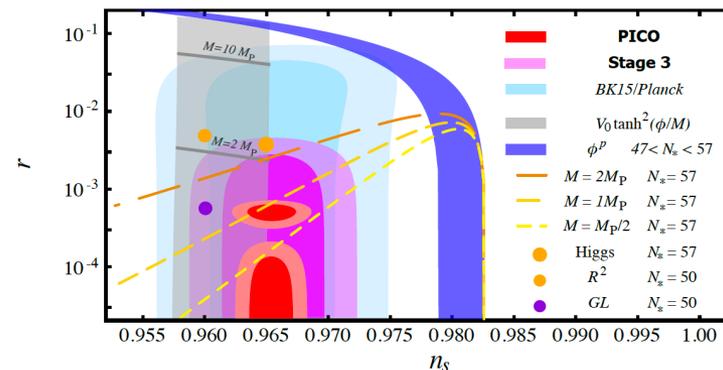
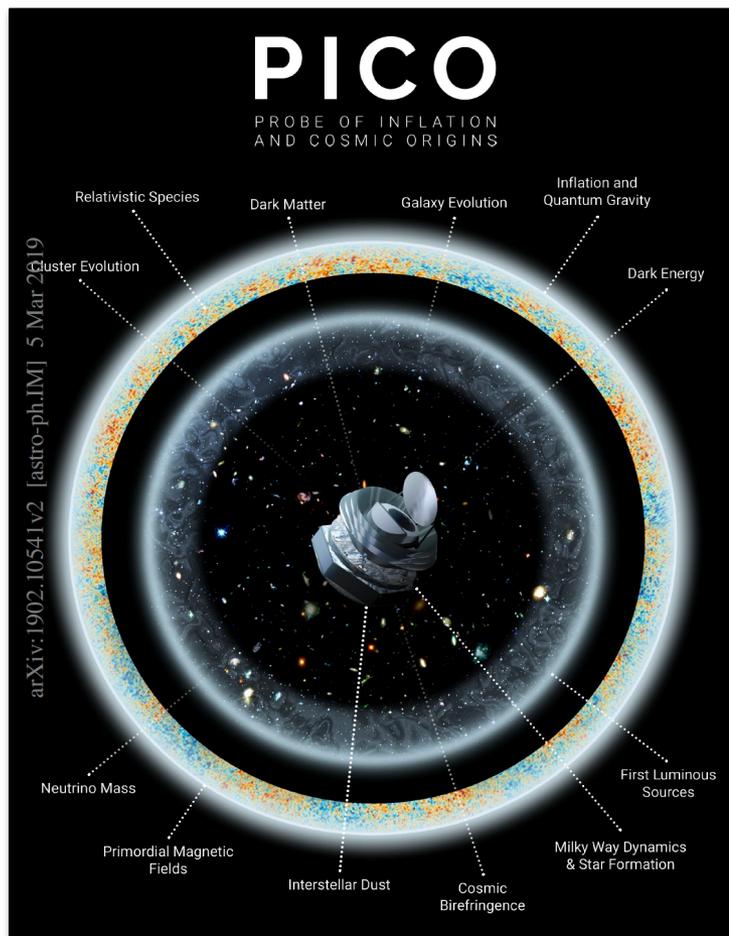
- Organized session at April APS 2020, Washington, DC
 - IPSIG Update
 - PICO (Probe of Inflation and Cosmic Origins) update
 - *‘Building upon a legacy of successful measurements, the next decade holds tremendous potential for new, exciting CMB discoveries.....’*
 - Complementarity of Space and Ground-Based CMB Experiments
 - Interplay of Foregrounds and Systematics: The Case for Low-Frequency Observations
 - Connecting the CMB Foregrounds, Galactic ISM, and Magnetic Field Modeling with IMAGINE
 - Data Analysis - Do We Have All The Necessary Tools?
- Continue organizing sessions and engage the community

the Inflation Probe Science Interest Group highlights and updates

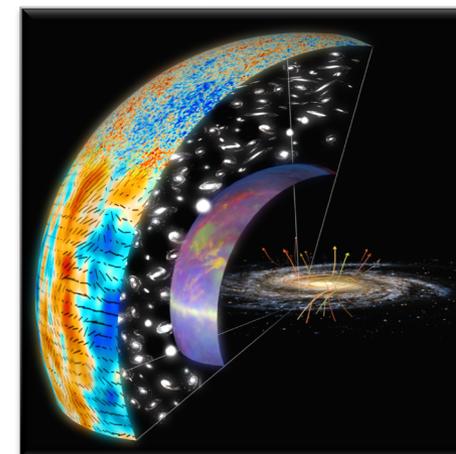
It's a exciting time for Inflation-probe science

Final report delivered to NASA and Astro2020

PICO APC paper

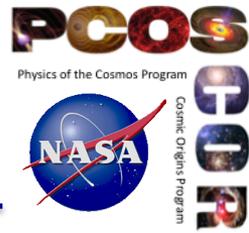


KISS study: Designing future CMB experiments



Several
APC papers

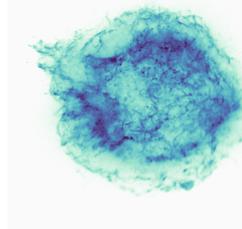
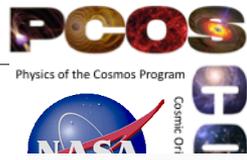
the X-ray Science Interest Group highlights and updates



☐ XR SIG

- Coordinated sessions at AAS in Seattle, HEAD meeting in Monterey, and the 2020 AAS meeting in Honolulu
- Produced webpage coordinating community Astro2020 Science White Papers
 - **> 50 Science White Papers** relevant to X-ray astronomy, covering very wide range of science, (including supermassive black holes and AGN, galaxies, groups, clusters, and the circumgalactic medium, star formation, the interstellar medium, exoplanets, supernovae and supernova remnants, stellar-mass black holes, and neutron stars)
 - XRSIG highlighted science in these White Papers at AAS and HEAD sessions.
- Provided a similar overview of Astro2020 APC papers for the 2020 AAS meeting in Honolulu
- Provided updates to the community on US involvement in Athena, and the progress of the NASA concept study for the Lynx Observatory.
- Major recent milestones in X-ray astronomy:
 - Successful launch in July of Spectrum X-Gamma S/C with eROSITA & ART-XC telescopes. Update on mission was given in the X-Ray SIG session at the AAS meeting in Honolulu

STATUS UPDATE
the X-RAY SCIENCE INTEREST GROUP



It's an exciting time for X-ray Astrophysics



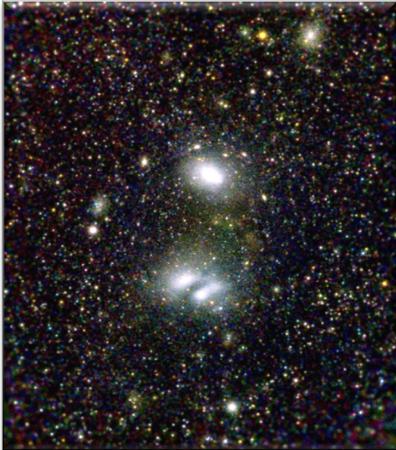
ATHENA

X-RAY OBSERVATORY
LYNX

The first data are exquisite

Recently passed Mission Formulation Review

Final Report delivered to Astro2020



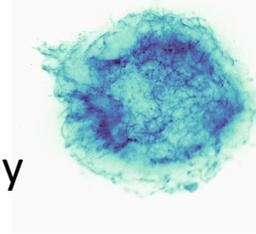
Not an optical image!



Transition to ESA Phase B1



A new epoch of discovery



The XRSIG Splinter at AAS 235 - (Standing room only!)

- Summary and analysis on APC White Papers to Astro2020 relevant to X-ray astronomy
- Update from recently launched SRG/eROSITA with a first look at some of the data
- Update on opportunities with 
- Overview of potential for a diffraction-limited X-ray mission

Organizing an excellent splinter for APS in April

XRSIG Goals for the coming year

It is the start of a new era for X-ray astronomy.

- As we await the results of Astro2020, the XRSIG will hold multiple events specifically designed to make X-ray astronomy more accessible to an even broader community.
- X-ray astrophysics is not niche science. It is a window into how our Universe really works.



PhysPAG EC current goals (under discussion)

- Improve access for (researchers at) under-resourced institutions
 - Discussing the ‘How’ – how to ascertain the needs of under-resourced institutions and how to proceed to improve access
- Assess Usability/Accessibility of data analysis tools and data representation
 - Assess the need for implementation as an integral part of technology development
- Preparation for Decadal outcomes:
 - Look into and analyze complementarities of flagships - with other flagships, and/or other potential future missions
 - Look at what other agencies are doing
 - Look into gaps in submitted science in APC white papers
 - Answer the question: *‘Where do you think your community is least well prepared for an outcome of the Decadal?’*

These discussions have been impacted by the current crisis

PhysPAG/SIG Meetings and Activities

- Winter AAS meeting, January 2020, Honolulu
- **April APS, April 2020, Washington, DC - Virtual Meeting**
 - PCOS/PhysPAG (this) session
 - **IP SIG session today 6:30 pm– 8:00 pm (ET)**
 - **XR SIG session tomorrow 6:30 pm – 8:00 pm (ET)**
 - GW SIG and GR SIG cancelled due to COVID-19 pandemic

https://pcos.gsfc.nasa.gov/physpag/meetings/APS_2020/APS2020-agenda.php
- **AAS HEAD, September 2020**
 - Planning begun, likely including X-Ray and Gamma-Ray SIG sessions
 - Let us know if you'd like to see something in particular!